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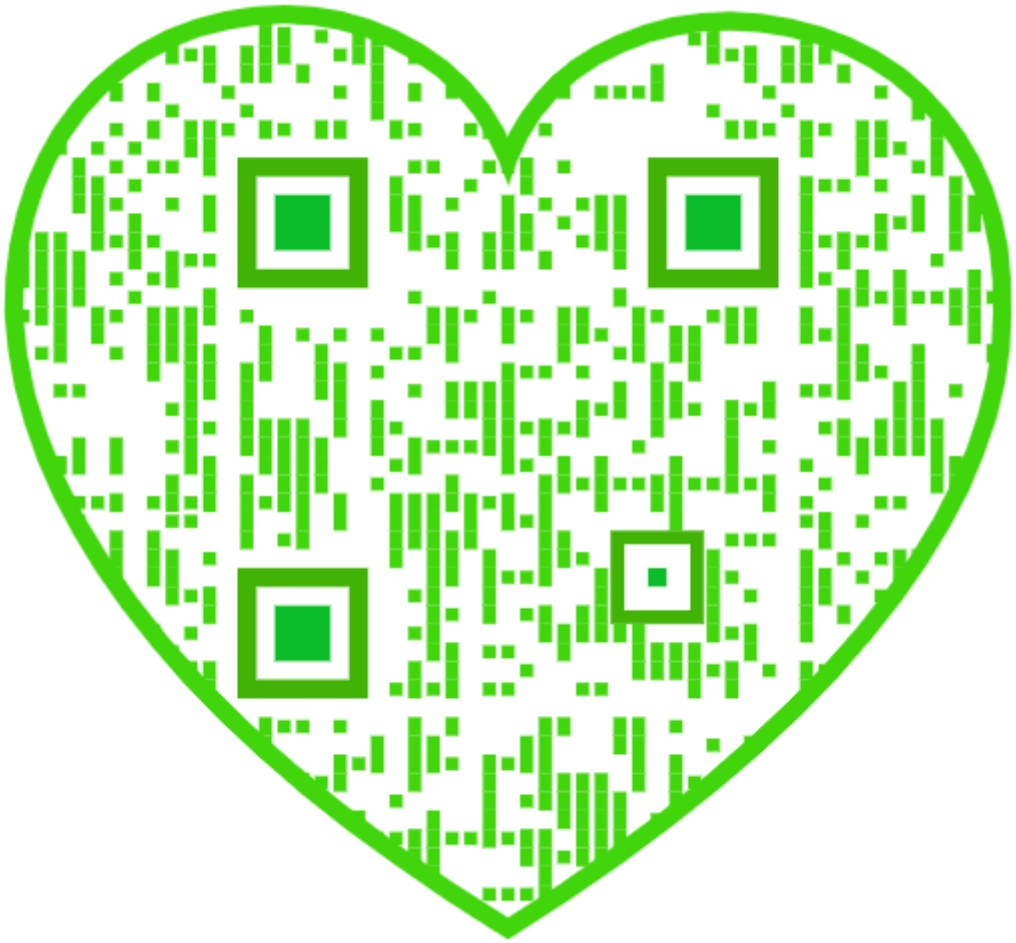

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DETECTION OF ARSENIC IN BEES

By E. B. HOLLAND

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DETECTION OF ARSENIC IN BEES[1]

By E. B. Holland

The high periodical mortality in numerous apiaries of the state during the past few years has led to the examination in the Station laboratory of many samples of bees and of comb submitted by the Station apiarist. As a rule, little information was obtainable except that a large percentage of a colony or colonies had died within two or three days. Disease was not considered the cause of death as no disease of the adult bee has as yet been recognized. On the other hand, the old theory of poisoning, so often advanced as a solution of like problems, appeared more plausible than usual in view of the fact that spraying with arsenate of lead or with Paris green has become the general practice of farmers, horticulturists and tree wardens for protection against leaf-eating insects. Furthermore, bees obtain pollen and nectar from a large number of "honey" plants over an area of approximately a dozen square miles (two mile radius)[2] and are very active during the spraying season. Bees, therefore, must be particularly liable to injury if arsenical or other "stomach poison" insecticides are used in the vicinity. The above assumption was substantiated in a large measure by chemical examination. A small amount of arsenic was found in 12 samples out of 23 submitted, as shown by the following table. The detection of arsenic in stored pollen was of special interest.

Results of Analyses

	Arsenic Present	Possible Trace	No Arsenic	Total
Bees	10	2	6	18
Comb	2	1	2	5
Percentage	52	13	35	100

At least 10 grams of material are deemed necessary for satisfactory work. Considerable labor is involved, however, in collecting that number of bees free from dirt and litter. As the amounts employed varied from 40 grams to less than 2, the tests are not strictly comparable. Moreover, the percentage of reacting samples was substantially reduced by including several lots secured in the course of the work that were not even suspected of poisoning.

[1] Published with the approval of the Director of the Massachusetts Agricultural Experiment Station.

[2] According to J. L. Byard, superintendent of the College apiary.

Methods for Destroying the Organic Matter

At the outset the organic matter in the samples was destroyed with sulfuric and nitric acids. These agents were first suggested to the writer by the late Dr. Goessmann in place of hydrochloric acid and potassium chlorate formerly employed for the purpose in the station laboratory. The process requires time and patience to insure *complete* destruction of the organic matter but is satisfactory as a whole and preferable to the old method.

As the number of samples increased and the demand for an early report became more urgent, an effort was made to improvise a process to meet those conditions with the least possible interference with regular work. An attempt at treating with potassium chlorate and igniting (an old method for wall paper) proved impracticable, and hydrogen peroxide proved inefficient as an oxidizer. Sodium peroxide, potassium bichromate and potassium permanganate were also considered. The last appeared the most promising and could be used readily as a saturated solution. The combined winter losses of two apiaries furnished a liberal supply of bees for experimental work.

Method Employed

Representative portions of the bees as received and with an added amount of arsenous oxide or of arsenic oxide were macerated in a platinum dish with a saturated permanganate solution (20 c.c. to each gram of material), evaporated to dryness, heated at a temperature not exceeding faint redness, pulverized and reheated until the residue would no longer "glow." The "crude" ash was transferred to a Marsh apparatus with sulfuric acid (1–3) and gave, in cases of added arsenic, a positive inside mirror. Several samples of suspected hay also reacted with the above test; evidently due to heedlesss spraying of the grass. Possibly permanganate has been used in this connection by other workers as it is now employed for many oxidizing purposes in most laboratories. Nevertheless, our method of procedure together with results secured are offered in the hope that they may prove of service.

Toxic Dose of Arsenic for Bees

So far as noted there have been no reliable data published as to the toxic dose of arsenic for bees. The arsenical compounds generally employed as insecticides are salts of lead, copper and lime. Although lead and copper have toxic properties, arsenic should be considered the active principle of the insecticide. Practical experience indicates that a given weight of arsenic (As) in the form of arsenites (As_2O_3) is more poisonous than in arsenates (As_2O_5). This appears to hold true

in relation to plant as well as animal life. While no positive statements are possible owing to lack of sufficient data, 65 milligrams of arsenous oxide (white arsenic) to 1,000 grams of live weight may approximate the toxic dose[1] for the horse, ox, sheep and fowl, and 9 milligrams for the dog and pig. On the former basis of susceptibility, 65 milligrams of arsenous oxide (equivalent chemically to 76 milligrams of As_2O_5) would kill 1,000 grams (net weight) of bees or 12,658 individual workers[2] weighing 79 milligrams each, or on the latter basis of susceptibility, 9 milligrams of arsenous oxide would accomplish the same results. The toxic dose for bees is unquestionably small, whatever the figure, as a considerable portion of the arsenic detected in the samples was evidently in the bee load and not assimilated as shown by the following treatment. A lot of bees containing arsenic, after being shaken with 1 per cent nitric acid for 1 minute and rinsed twice with water, gave only a "possible trace" of arsenic. Another portion treated similarly with 3 per cent nitric acid would no longer react. The use of 3 per cent acid proved inadvisable, however, as it was found too active for even so short a period. The above test would indicate that bees are susceptible to even less arsenic than is detected in the original samples.

The work will be continued during the coming season with a view of determining the amount of arsenic present.

[1] Calculated from data cited by Nunn, Veterinary Toxicology.

[2] Workers containing little or no feces average about 79 milligrams in weight; on leaving the hive in the morning during the active season the feces may constitute an additional 25 milligrams; a load of honey varies from 22 milligrams to several times that weight. From various references furnished by Dr. B. N. Gates of this Station.

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